

# *the* I.P. Sharp *newsletter*

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# 1980

## A YEAR FOR APL CONFERENCES

Rosanne Wild, Toronto

Conferences can be stimulating, not only through the ideas projected in the formal sessions, but through the opportunity registrants have for discussion with other APL users informally after hours. We are fortunate in that there are many quality APL conferences to attend. This year alone, there are three major APL events — STSC's Practical APL Conference, held in Washington in April; APL80, sponsored by the Netherlands Society for Informatics, held in Leiden in June; and the 1980 APL Users Meeting to be held in Toronto, October 6-8. Many large organizations with in-house APL systems also hold their own APL conferences. In March, Syracuse University held a day "In Celebration of APL" and invited guests from the central New York area. There will also be the Minnowbrook Implementors' Conference to be held in October of this year.

The ACM-sponsored conferences (APL76, APL79, APL81) have traditionally attracted people with a good knowledge of APL. The topics at these conferences vary from discussions on APL theory to industry applications. Although we sponsor our own APL Users Meeting every two years, we will continue to support the ACM conferences as we have always done in the past. The international APL community is large enough to support a number of conferences, especially when they are held in different countries and appeal to different levels of APL expertise and application.

Over the years, APL conferences have generated papers on a broad range of topics covering everything from the language itself to the use of APL in teaching. The formal proceedings published for most of these conferences continue to be sold in future years as a valuable reference tool.

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When we conceived the idea of having the 1978 APL Users Meeting, we wanted a conference that would appeal to **users**. We didn't neglect the specialist, but we wanted others, with perhaps no technical knowledge, to benefit from the sessions. And we wanted the users themselves to do the presenting—explaining the use of APL for practical applications in their organizations. The people who came found this approach to be a good one, and in all, the idea was well received with close to 500 people from 10 countries in attendance.

This trend towards a conference of a more "practical" nature prompted STSC, Inc. to sponsor their own conference this year entitled "A Practical APL Conference", focussing on user problems and their practical solutions. The conference attracted close to 400 people.

The 1980 APL Users Meeting is designed along the same lines as the 1978 meeting, with improved and expanded evening technical sessions. Early response indicates that attendance will far exceed that of 1978 with 700 registrants expected from all over the world. There will be 60 papers presented at the three day meeting providing a good mix of topics. If you're interested in the history of APL and its future, you'll enjoy listening to Garth Foster, Eric Iverson and Adin Falkoff speak on the first morning. Or perhaps you're interested in hearing Ken Iverson talk about the APL language. Economists will find both the evening seminar on Forecasting and Econometric Modelling, and the user papers on APL for Planning, Forecasting and Economics to be of interest. Most of you reading this newsletter should have already received a copy of the conference program detailing the broad range of topics, from sessions on "Managing APL Resources" to "APL Techniques and Programming Tools".

The 1980 APL Users Meeting promises to be the largest APL gathering of the year—an international event! We look forward to seeing many of you there. If you would like additional information, or if you would like to register, please contact:

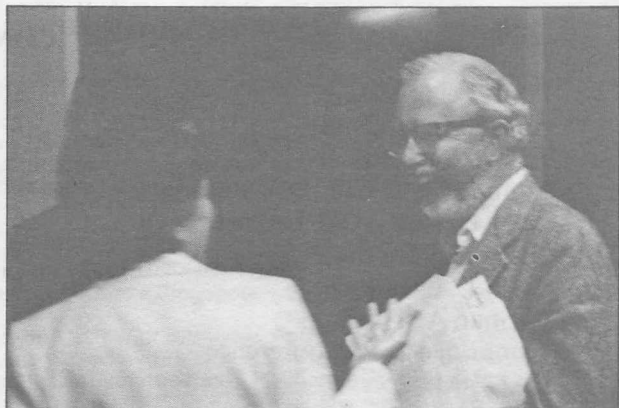
**Rosanne Wild, Conference Coordinator**  
**I.P. Sharp Associates Limited**  
**145 King St. West, Toronto**  
**M5H 1J8 Canada**

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### APL80 — AMSTERDAM, JUNE 80

Sharp people who presented papers were Ken Iverson, Eugene McDonnell, Bob Metzger and Ted Talbot. Special demonstrations offered by I.P. Sharp Associates included 4-colour plotting, an online APL bibliography with a user friendly front end, and various MABRA applications.

Ken Iverson, Gene McDonnell, and friends



## THREAT ANALYSIS

David Bonyun, Ottawa

I.P. Sharp Associates has prepared, for use on its APL system, a series of programs to assist those involved with the security of a system to perform a **threat analysis**. The techniques employed are derived from the study of a variety of methodologies in use by agencies in the U.S.A. and Canada. It is an outgrowth and a refinement of what has been called 'risk analysis', in which a quantity known as 'ALE' (the Annual Loss Expectancy) is computed. The I.P. Sharp technology refers to this quantity as an **exposure**.

The methodology adopted is perfectly general. It provides a default set of conditions and also the capacity to change any of them for those desiring a different model in which to work. The example used as the basis of the default conditions is of a computer-based information system, because this type of system has associated with it two **perils** which are not frequently found elsewhere. These are **disclosure** and **contamination**. (The other perils identified in the default case are **destruction**, **theft**, and **interruption**; this list may be changed as desired.)

Essentially the technique falls into three distinct phases. The first is to generate an inventory of **assets** within a number of predefined **asset categories**. This inventory is usually not the same as might be provided by the accounting staff because it includes, at least in our chosen example, data, software, and other forms of information and information handling tools. The inventory is then **evaluated** from a number of different perspectives as appropriate: these include initial cost, replacement cost, confidentiality, criticality, and others.

The list of asset categories and the perspectives used for evaluating individual assets are both changeable from the default conditions. There are ten asset categories identified in the default list: hardware, software, data, test data, communications, personnel, supplies, documentation, space, and service.

The second phase involves the determination, as methodically as possible, of the areas of **vulnerability** of the assets by category, by peril. A **threat** is defined to be a pair consisting of a peril and an asset category. Thus, **<DESTRUCTION;HARDWARE>**, **<THEFT;SUPPLIES>**, **<DISCLOSURE;DATA>**, and **<CONTAMINATION;SOFTWARE>** are all examples. (Note that **<CONTAMINATION;DATA>**, another possible threat, is the one which usually forms the basis for computer fraud.)

Those pairs which make no sense are discarded from the complete set of pairs formed in this way. The default conditions provide for 26 threats from the fifty pairs coming from the five perils and ten asset categories, but the user may change these as he chooses. The threat pairs which remain are studied in greater detail by considering each to be **realized** by a number of possible **events**. Each event is described by a scenario, and, for each, two parameters (which usually are only guesses) are requested from the user. These parameters are (1) the annual **frequency**, and (2) the average **severity** of the event. A costing function (employing the evaluative parameters associated with the threatened assets) and the two user-supplied values are used jointly for each event to calculate the **event exposure**. Costing formulae are provided in the default case, one for each of the 26 threats, but these may also be changed by the user.

Event exposures are summed leading to estimates of exposures by threat. Because all possible ways of executing or realizing a threat can never be imagined (and hence evaluated), the threat exposures are always low.

The third phase is to hypothesize protective **mechanisms** which may provide a degree of prevention, detection, or more rapid recovery. These may involve procedural changes, the acquisition of hardware or more personnel (such as guards), or techniques for backing-up systems and data. Each mechanism is evaluated using a **cost-benefit** program originally written by I.P. Sharp Associates for the Public Service Commission and the Treasury Board of the Government of Canada. This analysis indicates those mechanisms which are cost-effective in reducing exposures of various threats.

There are certain unique features of the I.P. Sharp threat analysis package which ought to be noted. Four are of special significance:

- (1) All arithmetic associated with the analysis is performed by the Sharp APL system. The programs are designed to request and accept data gathered on specially prepared data sheets. They also issue reports for the analyst and for management based on the data and the internal methodology.
- (2) Events are assumed to be of varying degrees of severity: although, for example, an earthquake may occur in a city, on the average, once every three years, its severity may vary from undetectable to extreme. Statistical procedures are built into the the package to account for this variance.
- (3) Certain mechanisms may reduce the exposure of an event by making the would-be perpetrators less willing to undertake it. Because many events are intentionally caused, rather than accidental, the package provides a greater degree of granularity in the analysis than simply a reduction in the annual frequency of the event following the introduction of such a mechanism. Provision is made, in fact, to analyse events from the point of view of the malicious agent in such cases, and to use the modifications in this perspective which result from the introduction of each appropriate mechanism.
- (4) Both a model (the collection of the default conditions) and a metamodel (the capacity to change any or all of these conditions, and hence to build a new model) are supplied. The resulting flexibility makes this package extremely sensitive to the needs of a wide variety of users. Not only computer systems, but any collection of assets which are susceptible to some form of threat or risk may be considered.

The analyses so far performed have indicated areas of vulnerability which would have gone unnoticed using other techniques. This methodology, while still being developed, is already recognised by many people in the field as one of the most detailed and comprehensive available, and its special features, listed above, make it quite unique. A textbook which describes in detail the methodology summarized here is, at the present time, in draft form. We expect it to be available in the next several months.

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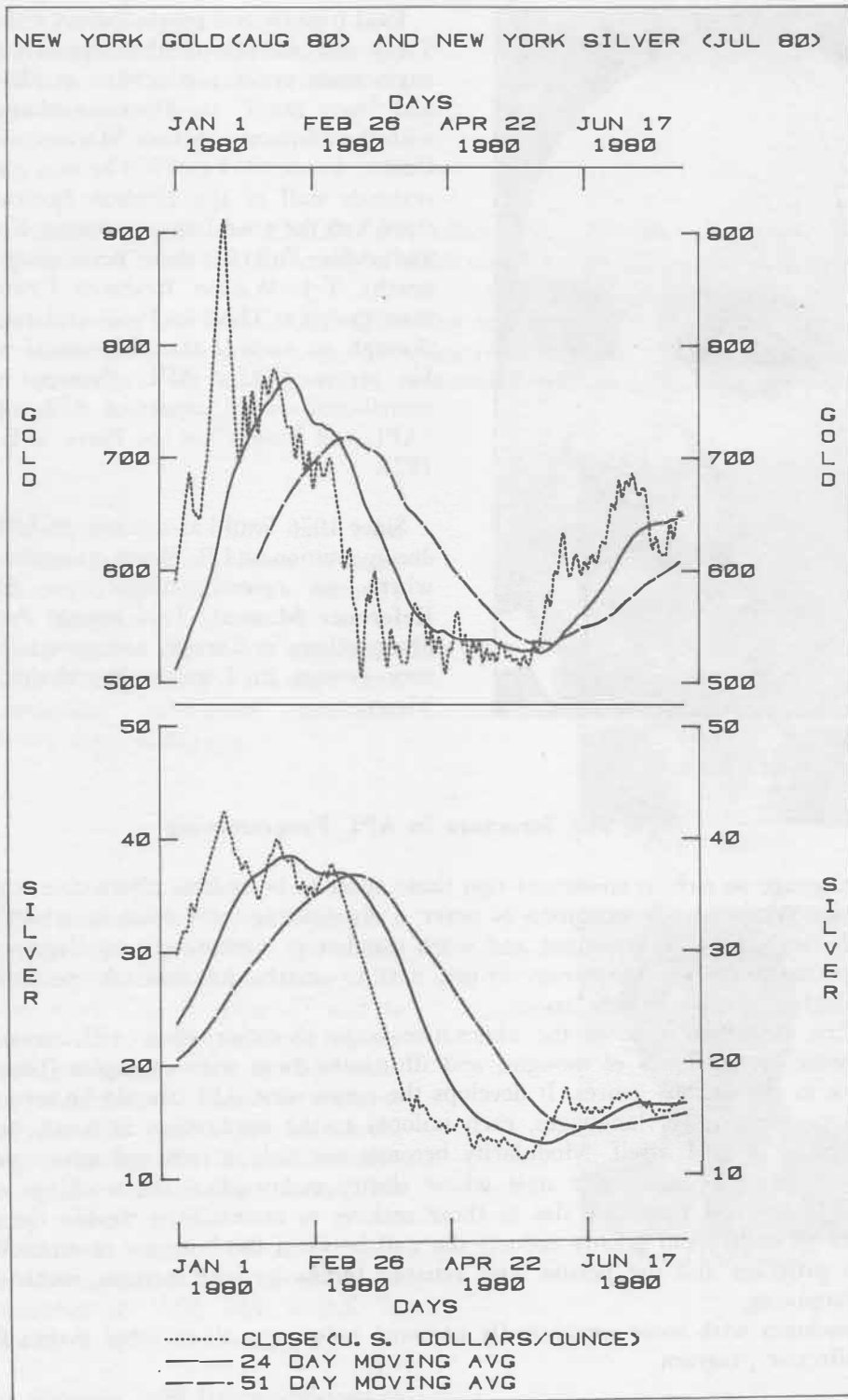
## COMMODITIES — U.S. FUTURES DATA NOW AVAILABLE

Marc Odho, Toronto

Eurochart's Commodity data base has been expanded to include data for twenty-four additional commodities traded on the New York and Chicago Futures markets. Now available are most of the large markets such as **soyabean complex, currency futures, and copper**, which now complement the previous substantial coverage of the London Futures markets. The open, high, low, and close prices are available for all major contracts along with the volume and open interest for each commodity as a whole. Data is available daily and monthly from 1973 to the present.

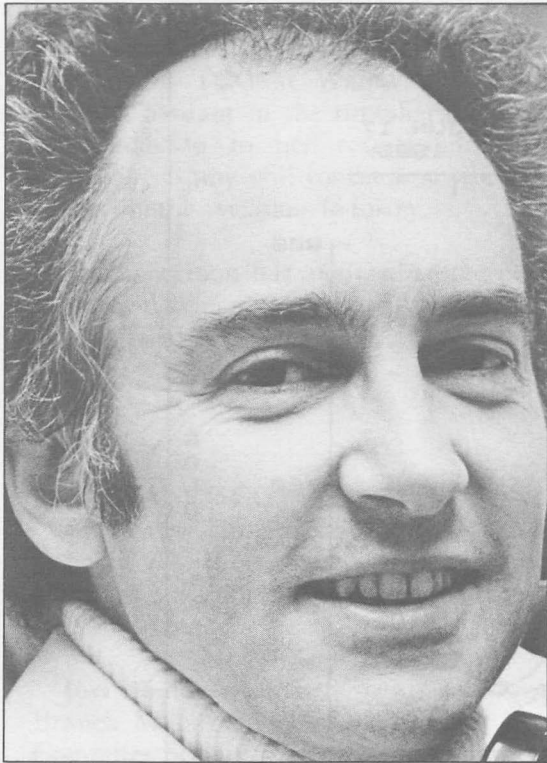
Commodities data can be accessed via *MAGIC* or *RETRIEVE*. Subscription to the data base can be arranged by contacting your Sharp APL representative or Eurocharts at: Knollys House, 11, Byward St., London, EC3R 5ED, England. Using *MAILBOX*, Eurocharts can be contacted via the code *CHART*.

The plot below graphically shows the increase in the price of gold and silver earlier this year resulting from the lack of confidence in the U.S. economy, vast silver purchases by the Hunt brothers in Texas, and a generally unstable political and economic climate worldwide.



## PAUL BERRY IS APPOINTED ACM LECTURER 80/81

Paul Berry, who writes on APL topics at our Palo Alto office, has been added to the list of ACM Lecturers for the academic year 80/81, thereby becoming one of their two speakers on APL. ACM is the Association for Computing Machinery, and is the professional society for computing. Please join us in congratulating Paul on this honour.



Paul trained as a psychologist (with a Ph.D. from Yale) and worked in that capacity on studies of engineering systems, education in Haiti and Samoa, and "new math" in American elementary schools with the Minnesota School Mathematics and Science Center. From 1964 to 1966 he was a member of the research staff of the Hudson Institute, and while there had the good fortune to meet Kenneth Iverson and Adin Falkoff, then developing APL at the nearby T.J. Watson Research Center. He joined their group at IBM in 1966, and remained with it through its various transformations over ten years. He wrote IBM's **APL Primer** in 1968, and contributed several papers on APL topics, including "APL and Insight" at the Paris APL conference in 1971.

Since 1976 Paul has worked on APL training and documentation at I.P. Sharp Associates in Palo Alto, where he recently wrote the **SHARP APL Reference Manual**. This spring, Paul visited I.P. Sharp offices in Europe, and gave talks before APL user groups in London, Stockholm, Zurich, and Vienna.

The abstract of Paul's lecture:

### Style and Structure in APL Programming

APL is a language so rich in constructs that there seem to be endless alternative ways to organize almost any task. While speedy execution is never a disadvantage, the style in which programs are written and the way they are organized and work together is increasingly significant. The desire to have programs that make sense, are easy to use, easy to understand, and easy to maintain becomes both a psychological and an esthetic issue.

This talk first describes some of the alternative ways of constructing APL programs. Then it characterizes some rival schools of thought, and illustrates them with examples (both splendid and horrid) of work in the various genres. It develops the notion that APL should be seen as a language for building even higher-level languages, each tailored to the application at hand, but sharing the fundamental syntax of APL itself. Modularity becomes not only a practical technique for avoiding repetitive coding, but the basis for a style whose clarity makes plain the workings of a family of programs both to the end user and also to those seeking to maintain or modify the code. Making programs easier to understand greatly reduces the gulf between the business or scientific patron who commissions a program and the person who actually builds it, with striking consequences for the sociology of computing.

The talk concludes with some unabashedly personal judgments about what makes for a pleasing, elegant, and effective program.



## OAKHILL PGA TOURNAMENT SCHEDULED WITH MABRA

Bob Lozo, Rochester

Applications for MABRA seem to be endless. In June we met with members of the volunteer committee for this year's PGA Championship held on August 7 - 11 at the beautiful Oakhill Country Club in nearby Pittsford, NY. Sharp's proposal to use MABRA as a means of organizing and formatting information concerning more than eleven hundred tournament volunteers was well received and consequently implemented. The results were tremendous. Formerly, tournament planning had been done entirely by hand, which was extremely time-consuming, often confusing, and always error-ridden. Thanks to the versatility inherent in MABRA, tournament directors had no trouble adapting it to meet their requirements. Pertinent data included personal information (name, phone number, age, sex, Oakhill membership status, etc.), the position(s) requested, and the assignment days and shifts of each volunteer. The completed system contained 60 fields.

Here's an example of how the system was used: of the 17 available positions for which an individual might volunteer (marshalls, walking scorers, transportation, etc.), he or she might choose five. These were numbered in order of preference and then entered into the appropriate fields. Using the constraint *MARSH=1* and requesting the *LNAME*, *FNAME*, *PHONE* and *MARSHALL* fields, the information on 275 individuals was printed — those who had ranked marshall as their first choice. Since 300 marshalls were needed, the remaining 25 were taken from a field called *ANY*, or those people who were willing to accept any assignment. In order to prevent duplication of names (those volunteers who listed both *ANY* and *MARSHALL* among their choices), a mutually exclusive constraint was used, i.e. *ANY>0^MARSH=0*. If a scheduling conflict could be avoided, it was possible to schedule as marshall individuals who listed marshall as a second or third choice.



The Unknown Golfer

The real fun began when setting up assignment and shift fields. Work shift standardization among the different positions was non-existent. Not only did the shifts differ from job to job, but also from day to day with each position. We solved this problem by setting up four fields for each day of the eight day affair. Activity codes were entered here, and each code translated into the time span associated with that shift for that activity. In conjunction with this, an assignment field was set up called *ASG*. A code entered into a shift field was automatically translated into an alpha code that went into the *ASG* field. Then, by using a constraint such as *ASG=M*, we were able to find all of the people who were assigned as marshalls, using a prepared program from *MABRAUTILS*. A nice schedule display was produced for each committee chairperson.

We are hopeful that the success of this project may result in the PGA using MABRA in the planning of future PGA (and possibly LPGA) tournaments. Special thanks go to Lael Kirk, Steve Halasz, and Barb Siebert for their suggestions — their assistance throughout this project was greatly appreciated.

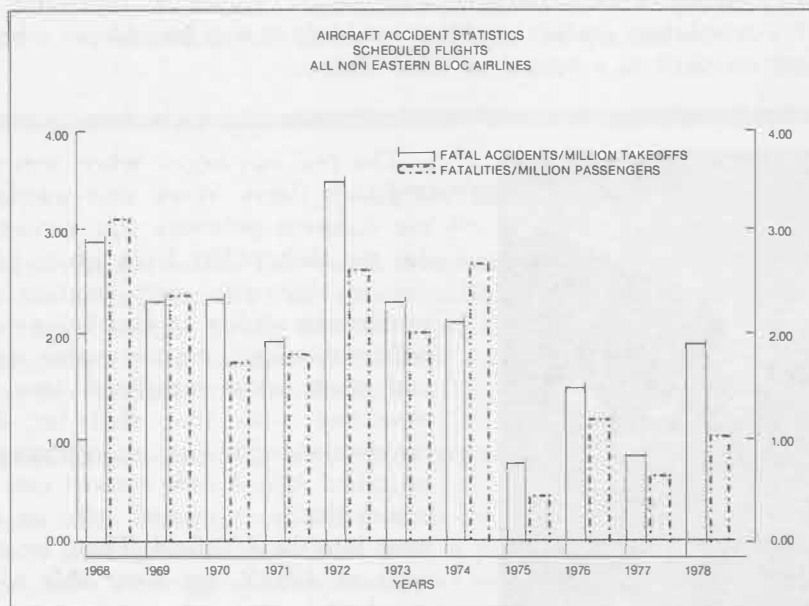
**A.I.S.L. AIRCRAFT ACCIDENT DATA BASE**

Peter Airs, London England

A new data base of interest to aviation insurance companies is available through I.P. Sharp. The A.I.S.L. Aircraft Accident Database is a MABRA system containing details of some 800 aircraft accidents. It is updated as accidents occur. Although fatal accidents number less than four per million take-offs per year, there are, each year on average, 40 turbine-powered airliners destroyed or permanently removed from service as the result of accidents. Information is recorded on the system as soon as it is available, and in some cases even before details begin to appear in newspapers.

The database is comprehensive. It contains factual information on all jet and turboprop airliner losses for aircraft of 20,000 lb weight and over. A complete history of these accidents is recorded on the database going back to the first such accident in 1952. As well as using MABRA to list and cross-tabulate the data, information can be retrieved and manipulated in time series form through an interface with the MAGIC system. There are some 30 data fields for each accident, including the date, location, aircraft type, serial number, operator, type of service (scheduled/passenger/freight etc), phase of flight (take off/landing, etc.) and details of passenger and crew fatalities.

A.I.S.L. is the Aviation Information Services Ltd. It is a subsidiary of the AIRCLAIMS group which specialises in aviation data and, in particular, aircraft accident statistics for the insurance market. There is a subscription charge of 40 pounds sterling per quarter, and 100 pounds per year, or the sterling equivalent in local currency at current exchange rates. Two user Manuals are available, **A.I.S.L. - Aircraft Accident Database** (from the London IPSA office), and the **MABRA User Manual**.



**GERMAN APL SPECIAL INTEREST GROUP**

During the recent APL conference in Holland, the formation of a European APL interest group, based upon the existing national organizations, was discussed. In spite of the widespread use of APL in Germany, there is no such German group. The following people are in the process of setting one up, and anyone interested in taking part should contact one of them.

- Kenneth K. Waller**, Pfadler-Werke AG,  
Postfach 1780, 6830 Schwetzingen
- Mike Bergen**, LKS AG, Frankfurter Allee 10-12,  
6236 Eschborn 1
- G.H. Robinson**, I.P. Sharp GmbH, Leostrasse 62A,  
4000 Duesseldorf 11.



# Technical Supplement-28

## EXPONENTIAL SMOOTHING

Robert H. Morris, Eastman Kodak Company

The use of exponential smoothing as a technique for tracking and predicting the behaviour of a discrete time series has been discussed by (among many others) Brown [1,2] and Morris and Glassey [3]. In particular, Brown and Meyer [1] have shown how to obtain the coefficients of the local, exponentially weighted, least squares quadratic by computing linear combinations of iterated smoothings.

The purpose of this note is to point out that with the help of a little algebra and of APL, the process can be greatly simplified, both notationally and computationally.

The procedure, as stated in conventional algebraic notation, is as follows:

1. Smooth the given time series,  $X$ , three times:

$$(1.1) \quad S_t^1 = \alpha X_t + (1-\alpha)S_{t-1}^1$$

$$(1.2) \quad S_t^2 = \alpha S_t^1 + (1-\alpha)S_{t-1}^2$$

$$(1.3) \quad S_t^3 = \alpha S_t^2 + (1-\alpha)S_{t-1}^3$$

where  $0 \leq \alpha \leq 1$  is the so-called smoothing constant and is chosen as a trade-off between the amount of smoothing to be induced and the amount of responsiveness to be achieved to changes.

2. Compute A, B, and C as the coefficients of the approximating quadratic.

$$Y_{t+k} = A + Bk + Ck^2$$

$$\text{from } [A \ B \ C] = [S_t^1 \ S_t^2 \ S_t^3] M$$

where the elements of the  $3 \times 3$  matrix,  $M$ , are rational functions of the smoothing constant,  $\alpha$ .

3. And finally, retain  $S^1 \ S^2 \ S^3$  for the next iteration.
4. For each  $t$ , the basic smoothing equation (1.1), can be written in APL as:

$$S \leftarrow X + \text{ALPHA} \times X - S$$

which eliminates one multiplication, one pair of parentheses, and the subscripts. Further, since

all the operations in step 1 are linear, and since in APL a variable name can refer to a written array as well as to a single number, step 1 can be written:

$$S \leftarrow (X, S) +. \times P$$

where  $S$  is a  $3=1$  matrix of smoothed values,  $X$  is the newest datum,  $P$  is a  $4=3$  matrix of rational functions of  $\alpha$  and the operator  $+. \times$  means conventional matrix multiplication.

Next, we note from step 2 that if new values of  $A$ ,  $B$ , and  $C$  can be computed from the current value of  $S$ , then the previous values of  $S$  can be computed from the previous values of  $A$ ,  $B$ ,  $C$ . Thus we can, if we like, store  $A$ ,  $B$ ,  $C$  for reference rather than  $S$  (since the values of  $S$  are, in themselves, less interesting).

Finally, since the new values of  $A$ ,  $B$ ,  $C$  can be obtained by a matrix operation on the new values of  $S$ , and they in turn, by a matrix operation on the old  $A$ ,  $B$ ,  $C$ , these can be combined into one matrix operation on the old  $A$ ,  $B$ ,  $C$ , viz.

5. 
$$A \leftarrow (X, A) +. \times Q$$

where now, the elements of the  $4=3$  matrix  $Q$  are cubic functions of  $\alpha$  which can be evaluated for a specific value of  $\alpha$  by executing:

$$Q \leftarrow ALPHA \uparrow R$$

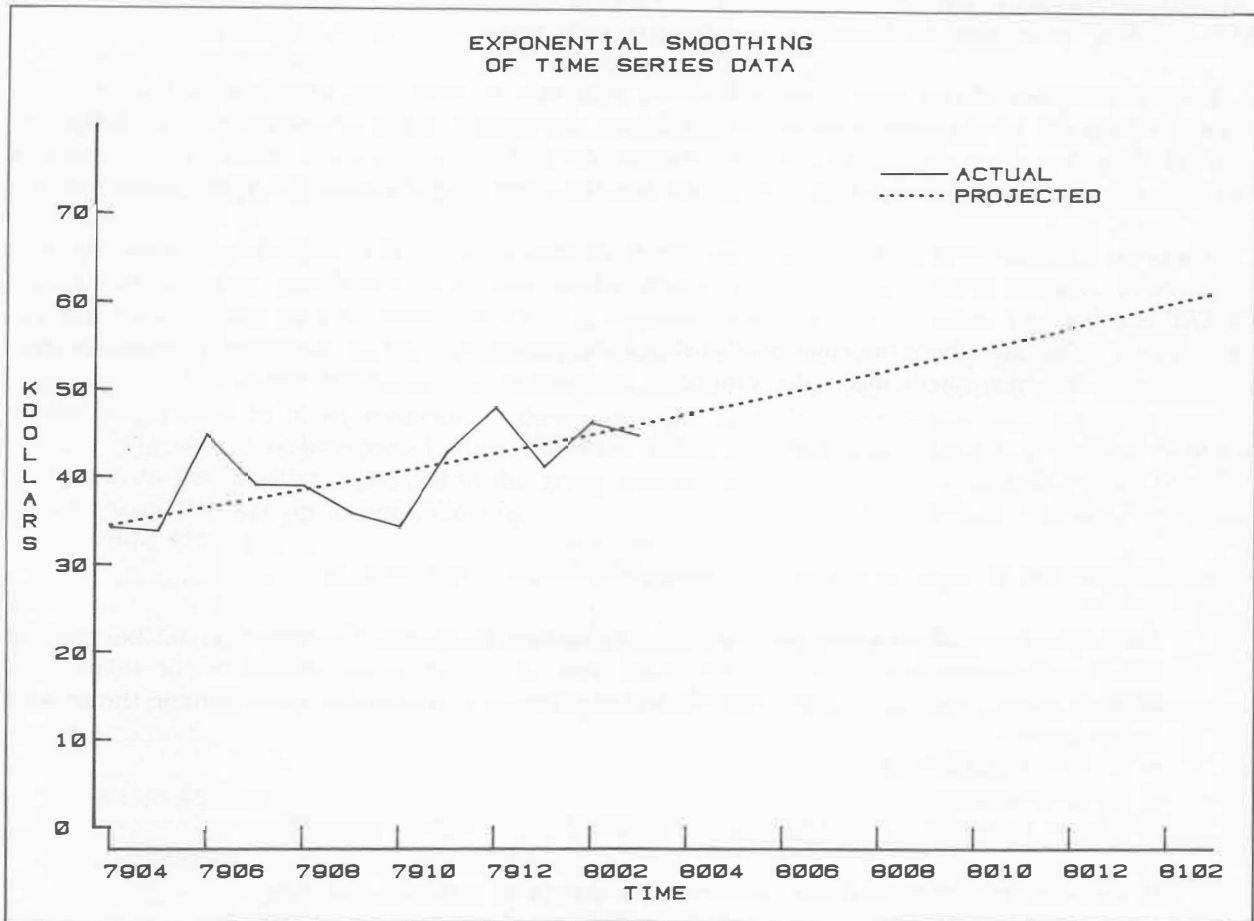
where  $R$  is the  $4 \times 4 \times 3$  array of constants:

	<i>R</i>		
1	-1.5	.5	
-1	1.5	-.5	
-1	1.5	-.5	
-1	1.5	-.5	
-3	3	0	
3	-3	0	
3	-3	0	
3	-3	0	
3	0	0	
-3	0	0	
-3	0	0	
-3	0	0	
0	0	0	
1	0	0	
1	1	0	
1	2	1	

The smoothing technique as described above can be used in conjunction with computer graphics software (such as IBM's GAP) to produce a plot of observed and extrapolated data as illustrated.

References

- [1] R.G. Brown and R.F. Meyer, **The Fundamental Theorem of Exponential Smoothing**, OPNS. RES 9 673-685 (1961).
- [2] R.G. Brown, **Smoothing, Forecasting, and Prediction of Discrete Time Series**, Prentiss-Hall (1962)
- [3] R.H. Morris and C.R. Glassey, **The Dynamic and Statistics of Exponential Smoothing Operators**, OPNS RES 11 561-569 (1963).



ROUNDING PUZZLE

(July/August 1980)

Linda Furrow, Calgary

Here are some of the solutions proposed:

- RND1:  $T \times \lfloor .5 + \omega \times T^{-1} \rfloor$
- RND2:  $(\lceil \omega - .5 \rceil \lceil 2 \times \lfloor (\omega + .5) \div 2 \rfloor$
- RND3:  $T1 - T2 - 1 < T2 < 2 \mid T1 \leftarrow .5 + \omega$
- RND4:  $\lfloor \omega + .5 \times .5 \neq 2 \mid \omega$
- RND5:  $(2 \times \lfloor (.5 + \omega) \div 2 \rfloor) + 1 < 2 \mid .5 + \omega$
- RND6:  $\lfloor \omega + .5 + (.5 = 1 \tau \omega) \times .1 \times \lceil 2 \rceil \mid \omega$

- ♠ Henri Schueler (8 functions)
- ♠ Itzhak Rosenbaum (8 functions)
- ♠ Roger Hui (8 functions)
- ♠ Morten Kromberg (6 functions)
- ♠ Roger Hui (9 functions)
- ♠ Steve Halasz (11 functions)

**SUBTOTALS and SUMMARIES**  
**The Bottom Line**

Robert Metzger, Rochester

The bottom line of a report presents the overall view of the information presented in a report. Most computer reports reduce large amounts of data to manageable size, sometimes by statistical analysis, or by calculating subtotals and summaries. The simplest summary is a total computed with sum-reduce (+/). Of course, APL also provides the means to compute cumulative totals with sum-scan (+\). All APL totalling techniques are based upon these two functions.

For the purposes of this article, we will define subtotals as sums computed from subsets of a set of data, which are interspersed with the original data. Summaries are also computed from subsets of a set of data, but they do not include the original data. Thus preparing a report which includes subtotals usually involves computing summaries and then inserting them in the appropriate places.

There is a simple method for doing these kinds of insertions in APL with three arrays. *DATA* is a matrix of original detail data. *SUM* is a matrix whose rows you would like to insert into *DATA*. *INSERT* is a boolean vector. It has as many elements as *DATA* has rows, and as many 1's as *SUM* has rows. The 1's indicate where the rows of *SUM* should be placed in *DATA*. If you have a setup like this, the following statements will insert the summary information in the proper rows.

```
EXPAND+(,INSERT,[1.5] 1)/,INSERT,[1.5] ~INSERT
DATA←EXPAND\DATA
DATA[(~EXPAND)/1ρEXPAND;]←SUM
```

This technique can be used to convert the summaries below into subtotals.

- (1) **The sub-arrays of an array are totalled at constant intervals.** For example, a 12×5 matrix would summarize into a 4×5 matrix. Each row in the summary would be the totals of 3 adjacent rows (4×3=12). The simplest and cheapest way to do this is to reshape the matrix into a cube:

```
+/[2] 4 3 5ρMATRIX
or more generally:
+/[2] ((1+ρMATRIX)÷INTERVAL),INTERVAL,¯1+ρMATRIX)ρMATRIX
```

If we want to summarize the columns of a matrix at constant intervals:

```
+/[3] ((1+ρMATRIX),((¯1+ρMATRIX)÷INTERVAL),INTERVAL)ρMATRIX
```

You can adapt this method to work along any dimension of any array.

- (2) A somewhat more complicated method of summarizing is necessary when you want to **total the sub-arrays of an array at varying intervals**. If you have a 12×5 matrix and you want to total rows 1,2, and 3 together, rows 4 and 5 together, rows 6,7,8, and 9 together, and rows 10,11, and 12 together, you can describe such a grouping with a partition vector. A partition in mathematics is a way of splitting a set into subsets. The vector has as many elements as the length of the dimension we want to partition. Each 1 in the vector represents the beginning of a new subset. Thus the partition vector which represents the example above is the following boolean.

```
1 0 0 1 0 1 0 0 0 1 0 0
(1 2 3 4 5 6 7 8 9 10 11 12) - row numbers
```

The following statements will summarize the rows of a matrix according to a partition vector:

```
TOTALS←(1ΦPARTITION)÷+∖MATRIX
```

$TOTALS \leftarrow TOTALS - 0, [1] \bar{1} 0 \leftarrow TOTALS$

Statements for summarizing columns with a partition vector:

$TOTALS \leftarrow (1 \Phi PARTITION) / + \backslash MATRIX$   
 $TOTALS \leftarrow TOTALS - 0, [2] 0 \bar{1} \leftarrow TOTALS$

You can generalize this technique to work along any dimension of any array.

- (3) In business uses of summary techniques, **the sub-arrays to be added together frequently are not adjacent to one another**. For example, to summarize an organization with several groups, each of which consisting of several units. If the groups are

$GROUPS \leftarrow 100 200 300$  and the units are  $UNITS \leftarrow 5 10 15 20 25 30 25 40 45$

then the organizational structure might be:

100: 5 25 30  
 200: 10 15  
 300: 20 35 40 45

If the data for the units is set up in ascending order, we will not be able to use the partitioning technique described above. We must now set up a summary control vector which will relate units to groups. It will have as many elements as there are units, and all of the values must be valid group numbers. The vector is interpreted thus: For each element in the vector, the unit number which corresponds to that position is related to the group number stored at that position. Thus the structure described would be set up as the following:

$SUMRY \leftarrow 100 200 200 300 100 100 300 300 300$   
 ( 5 10 15 20 25 30 35 40 45) - unit numbers

The position in the summary control relates to the unit, the value to the group.

With this structure, we can embellish on the partitioned algorithm to do the summarization of the rows of a matrix.

$GRADE \leftarrow \Delta SUMRY$   
 $CONTROL \leftarrow SUMRY [GRADE]$   
 $PARTITION \leftarrow (\bar{1} \leftarrow CONTROL \neq 1 \Phi CONTROL), 1$   
 $TOTALS \leftarrow PARTITION / + \backslash MATRIX [GRADE;]$   
 $TOTALS \leftarrow TOTALS - 0, [1] \bar{1} 0 \leftarrow TOTALS$

You can extend this algorithm to work along any dimension of any array.

- (4) This method works nicely for organizations which have one summary level (groups in our example). What if you need more than one summary level? Perhaps you have divisions composed of groups, and groups composed of units. There are two approaches. You can define all summary entities in terms of their bottom level entities; or you can define summary entities in terms of their immediate subordinates.

The summary control vector in the first method uses the ID numbers of the lowest level entities. The first entity in a summary is marked by multiplying it by  $\bar{1}$ . Thus the organizational structure listed below can be represented by the APL vector  $SUMRY$ .

$UNITS \leftarrow 10 20 30 40 50 60 70 80 90 100 110 120$

$SUM1: 10 20$   $SUM4: 50 60 70 90$

SUM2: 30 40 80  
 SUM3: SUM1+SUM2

SUM5: 100 110 120  
 SUM6: SUM3+SUM4

SUMRY←<sup>-</sup>10 20 <sup>-</sup>30 40 80 <sup>-</sup>10 20 30 40 80 <sup>-</sup>50 60 70 90 <sup>-</sup>100 110 120  
<sup>-</sup>50 60 70 90 100 110 120

Summarize a matrix using this structure as follows:

PARTITION←<sup>-</sup>1=×SUMRY  
 TOTALS←PARTITION†+∖MATRIX[UNITS<sub>1</sub> |SUMRY ; ]  
 TOTALS←TOTALS-0,[1] <sup>-</sup>1 0†TOTALS

Once again, you can easily adapt this method to arrays of different rank.

The advantage of the first method is that the programming is very simple. Rather than loop through several levels, data is repeated. Although it takes up more space, it uses less CPU time than some looping solutions might.

The alternative is to **describe the organizational hierarchy in terms of immediate subordinates**. This type of tree structure lends itself more to subtotalling than summarization.

The data array must already be expanded to allow for the subtotals which will be inserted. The summary control vector refers to sub-arrays of the data array. If we are subtotalling the rows of a matrix, the numbers in the summary control will refer to the rows of the expanded data matrix. Each number in the control tells which other row it contributes to. If a row contributes to no other row, the summary control has a 0 in that position.

A good example of this type of subtotalling are line items on a financial spread sheet. Some items total into others. Some stand alone. Others are totals of totals. This method handles all of these cases. If we have a matrix of 15 rows, where rows 1,2,3,5,6,9,10,11,13,14 are detail lines, and rows 4,7,8,12,15 are summary lines:

line 4 summarizes lines: 1 2 3      line 12 summarizes lines: 9 10 11  
 line 7 summarizes lines: 5 6      line 15 summarizes lines: 12 13 14  
 line 8 summarizes lines: 4 7

then the summary control vector would be built like the one below:

4 4 4 8 7 7 8 0 12 12 12 15 15 15 0  
 (1 2 3 4 5 6 7 8 9 10 11 12 13 14 15) - line numbers

Given such a structure, the programs listed below would do the subtotalling. *SUBTOTAL* is a recursive function. It calls itself, as many functions which process tree structures do, because trees are defined recursively. A tree is a set in which one of the members is a root, and the remaining elements, if any, are themselves trees. Notice that every element which does not contribute to another line is a root, and *TREETOTAL* is flexible enough to allow more than one root in a summary.



```

▽ MATRIX←SUMRY TREETOTAL MATRIX;POSITION
[1] LOOP:→(∼0∈SUMRY)/END
[2] A FIND NEXT ROOT NODE
[3] POSITION←SUMRY∖0
[4] MATRIX[POSITION;]←POSITION SUBTOTAL(POSITION=SUMRY)/∖ρSUMRY
[5] A MARK ROOT NODE PROCESSED
[6] SUMRY[POSITION]←-1
[7] →LOOP
[8] END:

```

▽

```

▽ TOTALS←POSITION SUBTOTAL INDEX;LEAVES;CTR;LIMIT
[1] A GLOBAL REFERENCES- MATRIX, SUMRY
[2] A WHICH SUBORDINATE NODES ARE LEAVES (TERMINAL NODES)?
[3] LEAVES←∼INDEX∈SUMRY
[4] A TOTAL SUBORDINATE LEAVES
[5] TOTALS←+MATRIX[LEAVES/INDEX;]
[6] INDEX←(∼LEAVES)/INDEX
[7] A LOOP THROUGH SUBORDINATE BRANCHES
[8] CTR←0
[9] LIMIT←ρINDEX
[10] LOOP:→(LIMIT<CTR+CTR+1)/END
[11] TOTALS←TOTALS+INDEX[CTR] SUBTOTAL(INDEX[CTR]=SUMRY)/∖ρSUMRY
[12] →LOOP
[13] END:MATRIX[POSITION;]←TOTALS

```

▽

It would be fairly easy to modify this method to handle subtractions as well. Sub-arrays which make a negative contribution could be multiplied by <sup>-</sup>1.

Business data processing frequently requires summarizing and subtotalling of data. These simple techniques will help the APL user to provide relevant information for management decisions.

**CORRECTION! DISPLAY OF ERRORS**  
 Technical Supplement 27, July/August 1980

The following error displays are the correct ones.  
 Please accept our apologies for the mis-aligned  
 examples in the previous issue.

Page T3 (top right): A quad level is represented by a prefix of a single quad symbol. It may be followed by one or more execute symbols, denoting execute levels:

```
□:
    ⑆ 'Z←A×÷B'
DOMAIN ERROR
□⑆   Z←A×÷B
      ^
```

Page T3 (middle): Errors occurring in □TRAP expressions are now prefixed by the sequence '□TRAP', rather than by the current six blanks.

```
'A' JOIN 3 3 ρ'ABC'
SYNTAX ERROR
□TRAP □SIGNAL ⑆4ρ
      ^
```

```
□ER
  2 SYNTAX ERROR
□TRAP □SIGNAL ⑆4ρ
      ^
```

Page T3 (bottom): Errors in □TRAP expressions may involve executes. When they do, the appropriate number of execute symbols will appear after the letters '□TRAP' in the display:

```
□TRAP←'◦ 0 C ⑆(1≠I28)/'÷0''
* ρ INTENTIONAL 'SYNTAX ERROR' TO TRIGGER TRAP
DOMAIN ERROR
□TRAP⑆ ÷0
      ^
```

Page T4 (bottom): When display of the failing □TRAP expression is suppressed, the error will instead appear as follows:

```
▽JOIN▽
'A' JOIN 3 3 ρ'ABC'
SYNTAX ERROR
□TRAP ▽
      ^
```

```
□ER
  2 SYNTAX ERROR
□TRAP ▽
      ^
```

## SPREADING THE WORD AMONG O.R. ANALYSTS

### I.P. Sharp Associates at EUROIV The Fourth European Congress on Operations Research

James Sinclair, London

O.R. analysts from 28 countries met in Cambridge last July. O.R. conferences have been, to date, the only exhibitions attended regularly by I.P. Sharp in Europe. They are much more intimate than the large computing exhibitions.

It was particularly noticeable at EURO IV that almost all the delegates had heard of APL and knew some of the main features of the language. This was in marked contrast to the O.R. conference at York two years ago. When we exhibited there visitors were asking such questions as 'What does APL stand for?'. Nowadays, the questions concern the suitability of various applications and the availability of APL in particular countries. One worrying aspect of the conference was the number of misconceptions that remain.

Several delegates had heard that APL was an excellent tool but also that 'It lacks any file-handling or report-formatting ability'. Sharp APL (and some others) have file handling and report formatting abilities far superior to those found in the languages they are currently using!



James Sinclair

The U.K. people from I.P. Sharp Associates ran a one-and-a-half hour session which was well attended. David Weatherby talked about APL in general; Graeme Robertson about SNAP — the new Sharp Network Analysis Program.

The Cambridge setting suited the general spirit of the conference well. Eating in King's dining hall would have been sufficient motivation to find the registration fee in itself, as was the Elizabethan feast and cabaret (whilst not directly relevant to O.R.). As with all conferences, the most important conversations happen, and the most interesting people are met, not in formal sessions or on exhibition stands, but in the bar and at dinner. Over eighty people asked for further information on our services — potentially eighty more users of APL in Europe. In practice, many of them will not have immediate applications, but the seeds are sown.

My only regret is that we had to wait until the final day, after we had packed up the stand, to find an hour for a punt on the river. And that we never did get to the Cambridge Real Ale festival.

## CANSIM UPDATE

Cathy Calvert, Toronto

In order to consolidate the various features of CANSIM, workspace 81 *CSUSAGE* has been revised to incorporate workspace 81 *CSNEWS*. Having the news facility combined with the access functions should make it easier to keep users up to date with changes to the data base. Users will be advised of the latest CANSIM update at signon, and a reminder will be printed when a news item has been added. The new workspace contains five groups. They are:

<i>ACCESS</i>	- for accessing the data e.g. <i>CSGET</i> ,
<i>DESCRIBES</i>	- on-line documentation e.g. <i>INQUIREHOW</i>
<i>MASSAGER</i>	- Sharp APL Massager Plus functions e.g. <i>AUTOCORRELATE</i> .
<i>NEWS</i>	- to use the CANSIM News features e.g. <i>NEWSITEM</i>
<i>XREFS</i>	- CANSIM cross-reference features e.g. <i>INQUIRE</i> .

The I.P. Sharp CANSIM data base contains all the series in the current Mini Base defined by Statistics Canada along with supplemental series requested by customers from the CANSIM Main Base. Due to the large number of supplemental series, currently over 30,000, there were a number of requests for a facility to identify these series. As a result, the cross-reference function *SUPPLEMENT* has been added, which returns as a result a sorted vector of matrix numbers that contain supplemental series. Using the function with the CANSIM Summary Reference Index, you can then search for particular matrix numbers. The search for supplemental series may be continued by using the function *INQUIRE*, which will list the data bank identifiers of the series available for specific matrices.

## NETWORK

Four new countries, **Bermuda, Taiwan, Luxembourg** and **Portugal**, and **Alaska**, gained Telenet access — the Value Added Network that connects to Sharp APL. On page 15 we show our new on-line maps with the Sharp Communications network superimposed. Non-IPSA network (VAN) access points are not shown here, but a list appears on the back cover. We will show the I.P. Sharp network node topology in alternate issues of the newsletter.

The I.P. Sharp Communications Network is growing steadily.

“Yes, the Rome office entrance from the street is an arch big enough for a fair size church. Amdahl are on the second floor in what must have been a private residence. The IPSA comms type turned plumber and removed a complete bidet in order to install the alpha rack. I won't comment on how the loss of the bidet affects the staff.... ”

“You may be amused to know that I have progressed from the Roman bidet installation to Schloss Sharp in Zurich, where two racks are squeezed into a circular room with very thick walls in an old tower!”

SHARP PEOPLE

ATLANTA

**Daniel P. Dezen** has joined the Atlanta office. A native of Maryland, Danny received his Baccalaureate degree from Emory University in 1979. The following year he was involved in sales and marketing for CMC Corporation of St. Louis. Since joining the company in July, Danny has rapidly learned Sharp APL, and is involved in supporting a major Atlanta client.

BRUSSELS

**Hazel O'Hare** has moved to the Brussels office to take over as Branch Manager, leaving **Pam Cocks** free to concentrate on clients in the aviation industry.

ALBERTA

**Pam Winters** recently joined the EMONTON office. Pam has an undergraduate degree in Mathematics and an MBA from the university of Alberta. Her interests are in management science and finance.

**Esther Tse** recently joined the CALGARY office. She was previously a librarian and a teacher in Singapore. Esther is currently working on an MBA degree in Finance at the University of Calgary.

**Frank Arthur** has temporarily taken over the responsibility of Branch Manager for Calgary in addition to his duties in Edmonton.

ABERDEEN

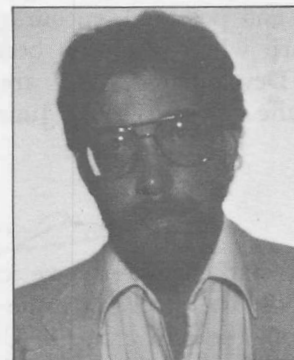
The staff at the Aberdeen office has been increased by the appointment of **Helen Wilson**. Helen is a mathematics graduate who formerly worked with the National Coal Board as an Operational Research Analyst. Helen has experience in Mine Construction Planning, Revenue and Expenditure forecasting, sales-price sensitivity analysis, and delivery date scheduling.



Helen Wilson

DENVER

The Denver office opened officially on September 1st. **David Osekavage**, the Branch Manager there, started with I.P. Sharp Associates in January 77, transferred to New York City in June 77 and to Newport Beach in January 78. He has been heavily involved in the aviation industry out in California, working with air carriers and manufacturers to develop numerous analytical public data base tools, various forecasting, planning, and financial models, and a passenger traffic management information system for a locally based carrier.



David Osekavage

David was first introduced to APL at Geneseo State University, Geneseo, New York, where he graduated in December of 1976 with a B.S. in Management Science.

"All skiers are welcome (and free ski lessons to those that wish to try)."

**NEW YORK**

**Ginny Marshalek** has been appointed the new Branch Manager. She has been the Marketing Representative, Aviation Industry, in the New York office since January 1979, where she worked with the Aviation data as well as some of our other public data bases including Petroseries and Imports.

Before joining Sharp, Ginny worked at The Computer Company marketing Aviation data, and previous to TCC at Wainwright Securities as a research assistant in the timesharing department.

In addition to her responsibilities as Branch Manager, Ginny will continue to work closely with clients in the Aviation industry.

**Keith Iverson** has assumed responsibility for the Northeast Region, but will still be based in the New York office.



Ginny Marshalek

**SAN FRANCISCO**

The latest thing in the San Francisco office is promotion. **June Sheppard**, former Branch Manager, has been appointed Pacific Northwest Region Manager.

**Jori Mandelman** is the new San Francisco office Branch Manager. Jori, who received her degree in Computer Science from the State University of New York at Buffalo, originally joined our company in January of 1974. After two and a half years she decided to work as a free-lance APL systems consultant.

In 1977 June Sheppard, the newly arrived Branch Manager, recognizing Jori's growing capabilities and potential, encouraged her to return to I.P. Sharp where she soon became Manager of Technical Development. We are sure she will continue the great job June has started.



Jori Mandelman

**SEATTLE**

Two new staff members have joined Branch Manager **Jennifer Morgan** in the Seattle office:

**Sue Rankin** was previously the Business Manager for a Seattle area engineering firm. She holds a degree from the University of California at Berkeley in History and Economics.

**Gary Powell** joined Sharp in March of 1980, and is transferring from our office in Rochester NY, where he has been involved in APL consulting and applications work. He holds a degree in Physics from Middlebury College in Vermont.



**APPLICATIONS SOFTWARE DEPARTMENT CREATED**

**Lib Gibson** has been appointed manager of a new Applications Software department. Companies are spending an ever growing proportion of their computer budgets on software development. The creation of an applications software department at Sharp will enable the company to better coordinate its already considerable involvement in application software development.

Software packages that "talk to each other", and that have consistent user interfaces to minimize the necessary user training, can greatly increase the value of packages to the users. The formalization of applications programming standards make packages much easier to maintain, and help to increase programmer productivity.

These are just some of the aspects of software development to be addressed by the new department. The department will also help to promote the company's growing business in the area of products sales to remote sites.

Lib would welcome comments from users regarding the types of packages they would find most useful.

**Clarke Bruce** has moved east where he will be joining the new Application Software department after working in the Calgary office for the past three years. Clarke's interest in finance and his continuing exposure to investment analysis and corporate planning and modelling while in Calgary make him a welcome addition to the group.



Clarke Bruce

In his new role Clarke will be available at any of Sharp's international branches to assist in implementing such models. During his tenure Clarke will also present a series of seminars discussing the philosophy and approach to the implementation of models for deterministic investment analysis.

---

**APPLICATION LIBRARY UPDATE**

*EPLAN* workspaces **merged:** 84 *EPLAN* (merger of 84 *EPLAN1* and 84 *EPLAN2*, since workspace size restrictions no longer apply.)

Lease Evaluation System: 128 *LESSOR*

APL COURSE SCHEDULE

CANADA

Edmonton

Introduction to APL, Sep.9-11  
 Intermediate APL, Sep.23-25  
 MAGIC (seminar), Sep.18  
 SUPERPLOT (seminar), Oct.2

Montreal

Introduction to APL (French), Sep.15-17, Nov. 3-5  
 Introduction to APL (English), Oct.6-8, Dec.8-10

Ottawa

Introduction to APL (non-programmers), Oct.7-9  
 Introduction to APL (programmers), Sep.2-5, Nov. 4-7  
 Intermediate APL, Sep. 16-17

Toronto

Introduction to APL, Sep.8-10, Sep.22-24,  
 Oct.14-16, Nov. 10-12, Dec.15-17  
 Intermediate APL, Sep.2-4, Oct.20-22  
 APL for Managers, Sep.18, Oct.23, Dec.10  
 Box-Jenkins, Sep.16, Nov.13  
 Data Structures/Shared Variables, Sep.17, Nov.20  
 Event Trapping (half day), Oct.8, Dec.4  
 Forecasting Methods, Sep.16, Nov.14  
 MAGIC for Time Series Analysis, Oct.9, Dec.12  
 Regression Analysis, Oct.17, Dec.19  
 Report Formatting, Sep.29, Nov.18  
 Saving Money with N- and B-tasks, Oct.10, Dec.18  
 SUPERPLOT, Sep.29, Nov.18  
 Text Editing, Nov.4-5

EUROPE

Amsterdam

Introduction to APL, Sep.22-24, Nov.17-19  
 Sharp APL, Sep.25-26, Nov.20-21, Jan.23-24

Copenhagen

Introduction to APL, Dec.1-3  
 Intermediate APL, Nov. 17-19

Paris

Introduction to APL (francais), Sep.3-5

Vienna

APL I Einfuehrungskurs, Sep.3-5, Nov.19-21  
 APL II Aufbaukurs, Okt.1-2, Dez.17-18  
 MABRA: Ein Management Informationssystem, Sep.17  
 Zeitreihenanalysen mit MAGIC, Sep.24  
 Highlights of Sharp APL, Okt.22  
 Planung mit APL, Okt.29  
 Graphics, Nov.5  
 APL fuer den Manager, Nov.12  
 Formatieren in Sharp APL, Dez.3  
 Sharp APL File System, Dez.10

U.K.

Aberdeen

Introduction to APL, Sep.1, Nov.12, Jan.26  
 Appreciation of APL, Oct.16, Dec.5

Coventry

Introduction to APL, Nov.18, Jan.5  
 Appreciation of APL, Sep.26, Oct.31, Nov.28  
 MABRA for Personnel, Sep.12  
 SNAP for Project Managers, Oct.17

Gloucester

Introduction to APL, Oct.13, Dec.1  
 Appreciation of APL, Sep.8, Nov.10, Jan.12

London

Introduction to APL, Sep.10, Oct.1, Nov.3, Dec.3, Jan.14  
 Appreciation of APL, Sep.22, Nov.17, Jan.9  
 Intermediate APL, Sep.15, Oct.20, Nov.24, Jan.21  
 Advanced APL, Sep.4  
 Introduction to SNAP, Sep.29  
 Advanced SNAP, Oct.30, Jan.29  
 Appreciation of APL for the O.R. Specialist, Sep.9  
 An O.R. Method - Box Jenkins - using Sharp APL, Oct.23  
 Record Management in O.R. Applications, Sep.1  
 Statistical Analysis for the O.R. Specialist, Oct.17  
 Critical Path Analysis using Sharp APL, Sep.18  
 Econometrics using Sharp APL, Sep.25  
 Linear Programming and simulation, Oct.28  
 Time Series Analysis and Forecasting Techniques, Sep.25

Warrington

Introduction to APL, Oct.27, Dec.8  
 Appreciation of APL, Sep.8, Nov.6, Jan.13

U.S.A.

Atlanta

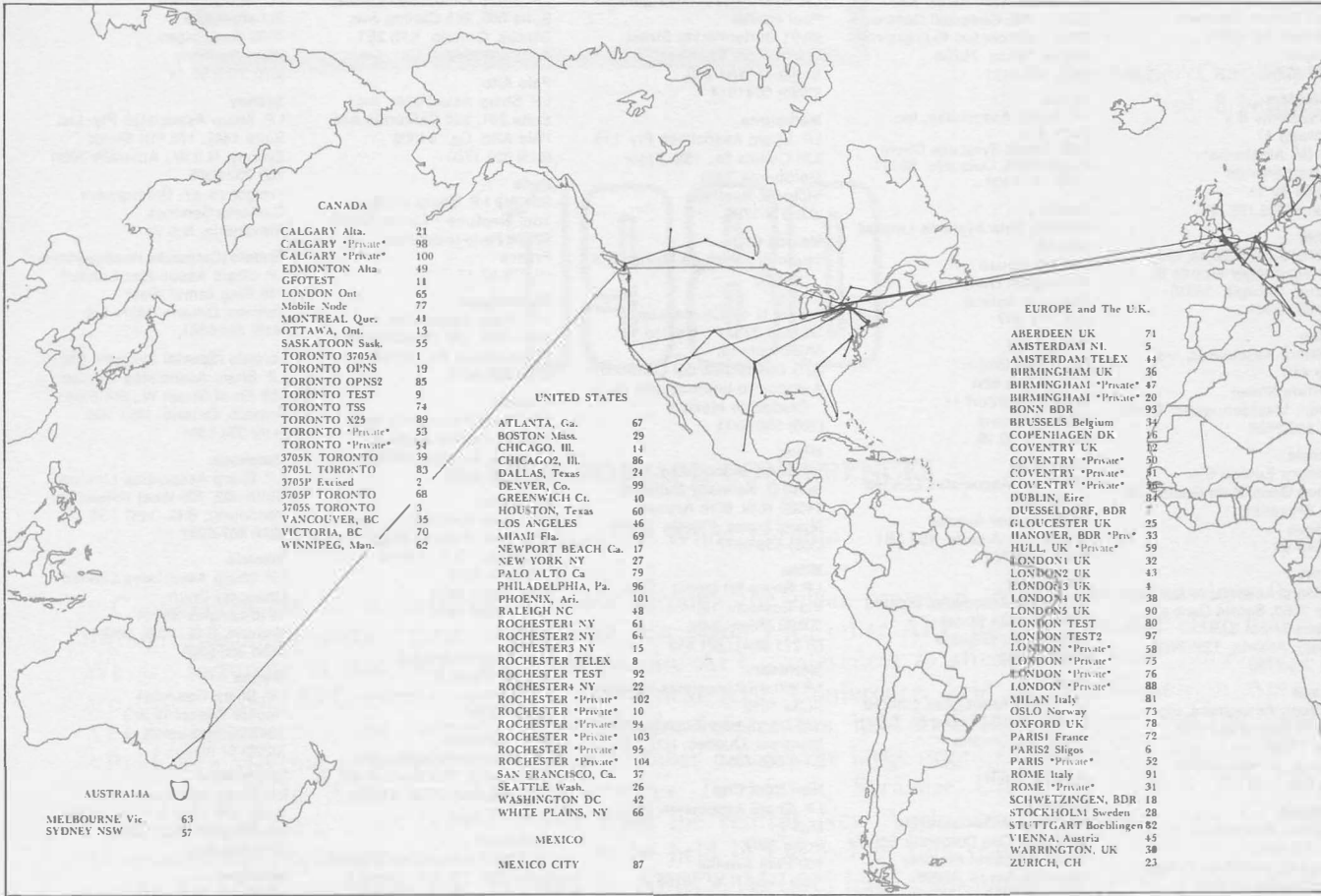
Introduction to APL, Dec.8-12

Rochester

Introduction to APL, Sep.15-17/22-24, Oct.20-22/27-29  
 Intermediate APL, Oct.6-7/14-15, Dec.1-2/8-9  
 Advanced APL Features workshops (4 half days):  
 - Package variables, Oct.2  
 - Batch APL, Oct. 9  
 - Event Trapping, Oct.16  
 - Shared Variables, Oct.23  
 Advanced APL Methods workshops (4 half days):  
 - Interactive dialogs & Terminal ctl., Sep.3, Nov.5, Dec.3  
 - Data structures and File design, Sep.4, Nov.6, Dec.4  
 - Systems analysis and design, Sep.11, Nov.12, Dec.10  
 - Program devpt., Debugging, and Testing, Sep.18, Nov.13  
 - Efficient programming, Sep.25, Nov.20, Dec.18

San Francisco

Introduction to APL, Sep.16, Oct.28, Dec.9  
 Intermediate APL, Oct.1  
 Advanced APL, Sep.25  
 Graphics, Nov.5  
 MAGIC, Nov.12



THE SHARP APL COMMUNICATIONS NETWORK

UPDATE

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I.P. Sharp Associates, Inc.  
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San Francisco, Ca. 94109  
(415) 673-4930
- Saskatoon**  
I.P. Sharp Associates Limited  
Suite 208, 135 21st Street E.  
Saskatoon, Sask. S7K 0B4  
(306) 664-4480
- Seattle**  
I.P. Sharp Associates, Inc.  
Suite 217,  
Executive Plaza East  
12835 Bellevue-Redmond Rd.  
Bellevue, Washington 98005  
(206) 453-1661
- Stockholm**  
I.P. Sharp AB  
Kungsgatan 65  
S111 22 Stockholm, Sweden  
(08) 21 10 19
- Stuttgart/Boeblingen**  
I.P. Sharp GmbH  
Schafgasse 3  
7030 Boeblingen  
West Germany  
(070 31) 2 30 14
- Sydney**  
I.P. Sharp Associates Pty. Ltd.  
Suite 1342, 175 Pitt Street  
Sydney, N.S.W., Australia 2000  
(02) 232-6366  
Freight to: c/- Greenways  
Customs Services  
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- Toronto (Corporate Headquarters)**  
I.P. Sharp Associates Limited  
145 King Street West  
Toronto, Ontario M5H 1J8  
(416) 364-5361
- Toronto (Special Systems Div.)**  
I.P. Sharp Associates Limited  
156 Front Street W., 5th Floor  
Toronto, Ontario M5J 1G6  
(416) 364-5361
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Vancouver, B.C. V6C 1G8  
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Victoria, B.C. V8W 1W2  
(604) 388-6365
- Vienna**  
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(0222) 57 65 71
- Washington**  
I.P. Sharp Associates, Inc.  
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Washington, D.C. 20006  
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- Winnipeg**  
I.P. Sharp Associates Limited  
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(204) 947-1241
- Zurich**  
I.P. Sharp A.G.  
Fortunagasse 15  
8001 Zurich  
Switzerland  
(01) 211 84 24

## SHARP APL Communications Network: Local Access Cities

APL OPERATOR VOICE (416) 363-2051 COMMUNICATIONS (416) 363-1832

Local dial access is available in all locations listed above. The SHARP APL Communications Network also provides local dial access in:

- Ann Arbor • Birmingham • Buffalo • Clewiston (Fl) • Des Moines • Des Plaines • Detroit • Ft. Lauderdale
- Greenwich (Ct) • Halifax • Hartford • Hull • Kitchener • Laurel • Liverpool • Los Angeles • Lyndhurst • Minneapolis
- Oxford • Raleigh • Red Deer • Regina • Santa Ana • Syracuse • Towanda • Ukiah • Warrington • White Plains (NY)

Our network connects with the Value Added Networks in:

- Alaska • Amsterdam • Argentina • Bahrain • Bermuda • Finland • Frankfurt • Geneva • Hawaii
- Hong Kong • Israel • Luxembourg • The Philippines • Portugal • Puerto Rico • Singapore • Spain • Taiwan

In the continental United States the SHARP APL Network is interconnected with the Value Added Networks to provide access in 170 more cities, and in Canada with 40 more. In all, with the 77 cities served by the I.P. Sharp Network listed above, SHARP APL is accessible from close to 300 places via a local phone call. Please ask at your nearest I.P. Sharp office for a complete list of access points and access procedures.